Solubility Equilibria

A saturated solution is one in which no more of the solute will dissolve, containing maximum quantity of solute that is normally possible at the given temperature

Solubility of a compound is the amount of solute that can be dissolved in 1 dm^3 of a given solvent (usually water) to form a saturated solution at a given temperature

Ksp is the solubility product, the product of molar concentrations of constituent ions in a saturated solution of a sparingly soluble salt, raised to the power according to the stoichiometric coefficients in the balanced equation for the equilibrium, at a given temperature

$$A_aB_b(s) \rightleftharpoons aA^{b+}(aq) + bB^{a+}(aq)$$

$$K_{sp} = [A^{b+}]^a[B^{a+}]^b$$

Take note: Ksp only varies with temperature

Relationship between s and Ksp

Let s be the solubility of the salt

No. of ions	Formula Type	Ksp
2 ions	AB	$[A^+][B^-] = s^2$
3 ions	A_2B	$[A^+]^2[B^{2-}] = (2s)^2(s) = 4s^3$
	AB_2	$[A^{2+}][B^-]^2 = (s)(2s)^2 = 4s^3$
4 ions	A_3B	$[A^+]^3[B^{3-}] = (3s)^3(s) = 27s^4$
	AB_3	$[A^{3+}][B^-]^3 = (s)(3s)^3 = 27s^4$
5 ions	A_3B_2	$[A^{2+}]^3[B^{3-}]^2 = (3s)^3(2s)^2 = 108s^5$
	A_2B_3	$[A^{3+}]^2[B^{2-}]^3 = (2s)^2(3s)^3 = 108s^5$

Ionic Product

- Basically Ksp but not at equilibrium
- Good to predict if solution is before or after saturation

IP > Ksp -> solution is saturated, and precipitate is formed

IP = Ksp -> Solution is saturated, but no precipitate

IP < Ksp -> Solution is unsaturated

Selective Precipitation of Ions

- Separation of ions in an aqueous solution by using a reagent that forms a precipitate with one or few of the other ions but not all
- Can be separated based on the different solubilities of salts
- Look at the minimum conc of reagent needed to precipitate out each ion -> the lowest one will precipitate first

Common Ion effect

Reduced solubility of a salt in a solution that already contains an ion that is common the the salt.

IP increases and exceeds Ksp, causing precipitation and hence lower solubility of the salt

Note: Ksp does not change

e.g. In pure water

$$AB(s) \rightleftharpoons A^+(aq) + B^-(aq)$$

Eqm Conc. s s

$$K_{sp} = s^2$$

In 0.2 mol dm^{-3} KB

$$AB(s) \rightleftharpoons A^+(aq) + B^-(aq)$$

Eqm Conc. s s + 0.2

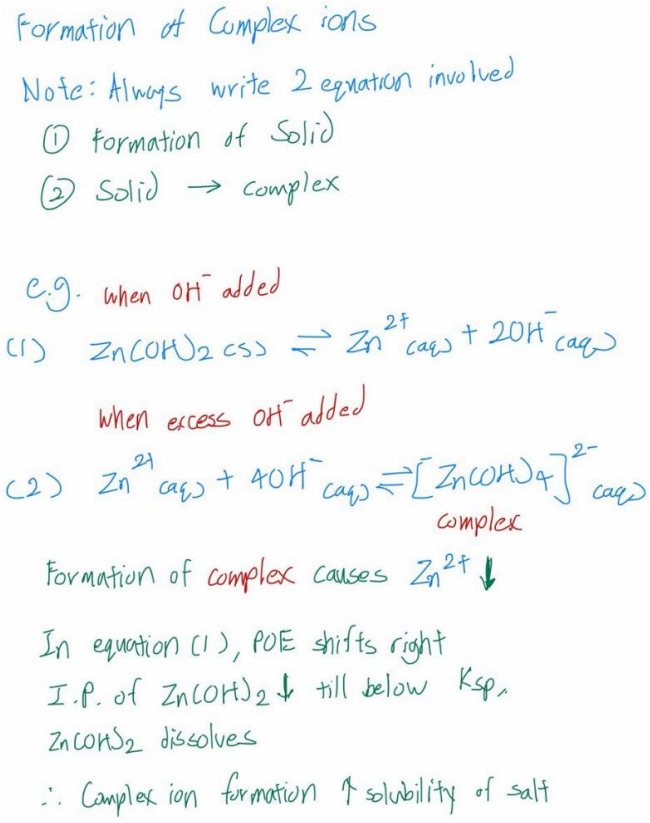
$$K_{sp} = (s)(s+0.2)$$

As $s \ll 0.2$, $(s+0.2) \approx 0.2$

$$\therefore K_{sp} = 0.2s$$

Formation of Complex Ion

- Sometimes complex ions are formed from a precipitate, leading to increased solubility of the salt overall



Effects of pH

In salts that use OH^- ion, these would be influenced by pH which tweak concentrations of OH^-